chapter seven

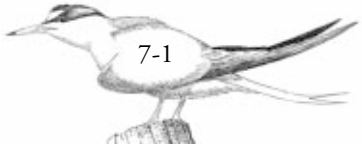
BIRDS

Birds are the most conspicuous animals inhabiting New England **salt marshes** because they fly around, sing, and attract attention. Birds have captured the imagination of artists and writers throughout time. For centuries, scientists and naturalists have studied avian life history, behavior, environmental requirements, and responses to environmental disturbance and pollution. The concept of using birds as **sensitive** environmental **indicators** has long been established. Historically, miners brought caged birds into mines to serve as indicators of air quality, giving rise to the expression "canary in a coal mine." More recently, scientists have studied how nesting, hatching, and fledging success can reflect environmental conditions. This chapter provides the guidelines and methods needed to conduct a **monitoring** project for salt marsh birds, and discusses how birds may be used as environmental indicators.

Wetland birds require certain types of **habitats** for different aspects of their lives such as nesting, feeding, perching, or migration. Salt marshes offer a variety of habitats such as mudflats, **pannes**, pools, various types of vegetation, and open water. Birds have evolved a variety of adaptations to exploit the resources in these habitats. For instance, herons and egrets have long legs well suited for wading in shallow water and beaks suited for catching fish and **invertebrate** prey, and therefore exploit shallow water habitats. Habitat **diversity** in salt marshes results from a variety of physical, chemical, and biological variables. Alterations to physical variables such as **hydrology**, chemical variables such as salinity, or biological **variables** such as vegetation will affect the type and distribution of habitats in a salt marsh, and therefore the biological communities that can live there.

Humans may alter the habitat that a bird requires. For instance, Salt Marsh Sharp-Tailed Sparrows require suitable densities of *Spartina patens* (salt hay grass) and *Spartina alterniflora* (smooth cordgrass) for nesting and feeding, and alterations to natural hydrology or salinity regimes may reduce the availability of these vegetation types. Humans may also alter the **abundance** of important prey items. For instance, herons and egrets require high densities of fish, and excessive pollution might reduce fish **populations** to the point where herons and egrets cannot get adequate nutrition. Birds that require specific habitats or conditions — called **specialists** — may avoid salt marshes that have been altered by disturbance or pollution, while birds that can tolerate a wide range of conditions — called **generalists** — may thrive in these areas.

Birds are long-lived and highly mobile, and over the course of their lives can learn to recognize favorable locations for breeding, nesting, feeding, and migration. Scientific research has shown that birds will choose wetlands that have the best conditions to meet their needs. Birds are usually able to recognize if the vegetation is suitable for nesting, or if prey abundance is sufficient for themselves and their young, and if predation risk is low. Birds prefer to avoid stressful situations, and will usually only occupy unfavorable habitats if competition forces them to leave favorable areas. Human land use may affect a bird's decision to inhabit a particular salt marsh — some birds avoid



Great Blue Heron

wetlands near highways and urban areas because of noise pollution, and large numbers of cats from suburban developments might be a deterrent for birds. Birds that seek out favorable habitats will be more healthy, more likely to have healthy offspring, and may be at lesser risk of mortality.

A complete list of pros and cons of using birds as indicators of wetland health is provided in Chapter Three. It is important to remember that birds are just one of several types of organisms that inhabit salt marshes. Although there are shortcomings to using birds to assess the condition of salt marshes, birds can yield insight that may be overlooked by studying only plants, invertebrates, or fish.

EQUIPMENT

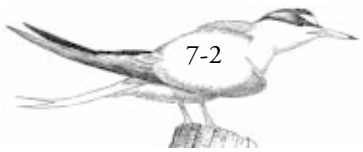
Of the **parameters** covered in this manual, birds are among the easiest and least costly to monitor. Volunteers only need five pieces of equipment to monitor birds: binoculars, field guides, recordings of birdcalls, pencil, and clipboard. Binoculars can be quite expensive, but most backyard birdwatchers and outdoor enthusiasts already have a pair. In addition to field guides, many people benefit from recordings of birdcalls. These are available on cassette or compact disc from a variety of sources. Both field guides and birdcall recordings are pieces of equipment that people should familiarize themselves with at home, not in the field. Field surveys require constant attention, and there is little time for looking at books (and especially not listening to recordings) during fieldwork.

SAMPLING METHODS

Scientists use two types of field protocols to monitor birds: area searches and point counts. Area searches require complete counts of all **species** and individuals at a site; this can be very time consuming and is therefore not recommend for volunteers. Point counts are conducted from a single vantage point overlooking the marsh, and require observers to record all species and individuals seen or heard within a fixed amount of time. The point count method is recommended because it is simple and volunteers can complete it quickly.

Procedure for Conducting Point Counts

1. Arrive between sunrise and eight o'clock when birds are most active. Bird calling and activity decreases during the day, and you can getter a better idea of bird communities by surveying during peak activity.
2. Locate a vantage point from which you can see a representative portion of a salt marsh, including the marsh border. You will want to use the same vantage point for all subsequent visits to the marsh.



BIRD ACTIVITY AND HABITAT

You can determine the importance of a wetland to a particular species by recording its activity and habitat usage. Here are some examples:

- Some birds (such as gulls, ducks, and hawks) will fly high over a wetland on their way to somewhere else. You should not count birds that are cruising high above a wetland unless it looks like they are hunting (such as an osprey looking for prey).
- Some birds (such as swallows, swifts, and flycatchers) cruise at low altitude over the marsh and feed on aerial insects. You should count these low-flying birds.
- Some birds feed almost entirely within the salt marsh yet nest and perch in adjacent wetland buffers because the vegetation may be more dense and protected. You should count birds in the marsh and the upland buffer and record where you observed them.
- Do your best not to count the same individual twice. Since birds may be flying around, this may be difficult. If a bird flies off in one direction and out of sight and then another individual of the same species appears to fly back from the same general area, it is quite possibly the same bird. Use your best judgment.
- If you cannot identify a bird, do not spend too much time looking it up in your book, since you will miss other birds that fly by. Jot a few good notes and try to figure it out later.

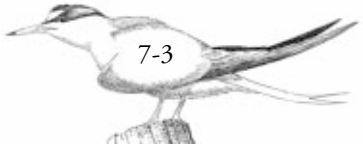
3. Record all species and individuals seen or heard for a fixed amount of time (ideally 20 minutes). You should count birds located in the wetland and a 50-100 foot wetland buffer.
4. Record the activity or habitat of each bird that you observe.
5. Completely fill out field data forms.

When comparing different sites it is important to conduct counts as close together in time as possible. Ideally, for sites that are being compared to each other, surveys should be conducted on the same morning to minimize the effects of different environmental conditions (especially weather and tides) on bird richness and abundance. The same observer(s) should monitor the sites to ensure a consistent level of expertise.

It is important to conduct surveys at different times of the year under different environmental conditions. This gives a better understanding of the importance of a wetland to breeding, migratory, and non-breeding birds. At a minimum, four surveys per site are recommended during the breeding and migration season (May to September). You may also consider monitoring wetlands during other times of the year to document use by non-breeding birds. Surveys should be conducted during different tidal conditions, since exposed mudflats at low tides provide important resources for some species, and high tides may force secretive species out of the vegetation where you can see them. In addition, survey 50-100 feet of the wetland buffer because many species use the buffer zone for nesting or perching (since the salt marsh itself provides few opportunities for this), yet depend on the wetland for other aspects of their lives such as feeding. The quality of the buffer zone also affects the quality of the salt marsh, and important indicator species will depend on both.

Bird Identification

Bird identification requires careful visual observations and keen auditory skills. Although some birds are very distinctive, many others look similar and often confuse even the most skilled observers. Some difficulty arises from the fact that many birds molt twice a year and the appearance of their plumage changes. Juvenile birds that have not developed adult characteristics will often be difficult to identify. Recognizing birdcalls can be an important means of identifying species, (particularly cryptic species), but commonly available recordings often do not include all species you will encounter. Many bird identification books are available, and rely on a suite of illustrations, photographs, and descriptions. For best results, gather the bird identification materials you are most comfortable with and use a variety of clues (shape, posture, size, coloration, behavior, habitat, and birdcalls) to identify species or groups of closely related species.



As stated previously, actual field surveys require constant attention by the observers so that they do not overlook any species or miscount individuals. Volunteers should spend several days practicing in the field before actually conducting field surveys to familiarize themselves with the birds and survey conditions. During these "practice runs," volunteers should follow a series of steps to narrow the range of possibilities for any given species and arrive at the proper identification; these steps are outlined below. Volunteers should not conduct actual field surveys until they are proficient with identifying birds by sight.

Semipalmated Sandpiper

The first step for visual observation is to determine what general type of bird you are looking at. You should know key characteristics for a few basic groups of birds, based largely on shape and posture. Familiarize yourself with the main groups of birds, many of which you probably already know to some extent, so that you can ask yourself simple questions such as:

- Is it duck-like? [Ducks, geese, swans]
- Is it gull-like? [Gulls, terns]
- Is it hawk-like? [Ospreys, eagles, hawks]
- Is it a wading bird with long legs? [Herons, egrets]
- Does it run along the ground like a sandpiper? ["Shorebirds" — sandpipers, plovers]
- Is it a perching bird? [Large group of birds, which includes most songbirds]

Once you identify the general group a bird belongs to, consult a bird book to find the species that the bird most resembles. You should be familiar with the organization of your book so you can quickly reach the appropriate section and spend more time comparing closely related species. It is sometimes helpful to take notes or photographs to assist in identification. Using common species for comparison, you should focus on details such as size (bigger or smaller than a Robin?), shape (long and thin or plump and round?), coloration (brown? what shade?), and any distinguishing marks or features (any streaking or other noticeable marks?). Pay attention to the bird's behavior, including feeding, resting, and flying, and the types of habitat it occupies. Be mindful of the time of year, because in the summer and fall you are likely to see immature birds or post-breeding adults whose plumage is different than what is illustrated in most books. Some groups of birds are difficult to identify, including sparrows, flycatchers, young gulls, fall warblers, and starlings (due to the many variations in their plumage).

Birdcalls are frequently more difficult to learn than visual cues, but knowing the calls will dramatically increase your ability to identify birds in the field. This is particularly true for birds that are cryptic or otherwise difficult to see because of weather, darkness, or heavy cover. Listening to birds as they are calling is perhaps the best way to learn their calls, because this "hands on" approach will enable you to create strong and long-lasting associations between a species' appearance and call.

Appendix 1 to this chapter provides a list of birds that are likely to occur in or near wetlands in northeastern North America. This list is based on the biology of each species and what volunteer groups have observed over several years of monitoring. The list should aid volunteers in bird identification by narrowing the search and serving as a reference

list. If you are not sure that you have identified a bird properly and it is not on the list, then it is likely that you have misidentified the bird. See if you can get another look at it. The list includes greater than 95% of the species you should expect to see in coastal salt marshes, though keep in mind that birds appear in unexpected places and there is always a chance of encountering unusual species.

DATA ENTRY

In The Field

A separate field data sheet should be used for each site and survey date. A blank sheet is provided in Appendix 2 of this chapter. You can modify field data sheets to suit the objectives of your study, but all data sheets should have the following types of information: observer(s), site location, a rough sketch of the study area with the vantage point location, survey date, weather, and tidal conditions. A good field data sheet will also include a sketch or photographs of the study area.

One person should perform all of the data entry so that entries are consistent. If two people are working together, one can observe while the other person records information. Data should be entered neatly and thoroughly so that there is not any missing, incomplete, or incorrect information. When the observations have been completed for a site, it helps to review the data sheet to ensure that all the necessary data are accurately recorded and that everything is legible, since the data are often entered in haste when there is a flurry of bird activity.

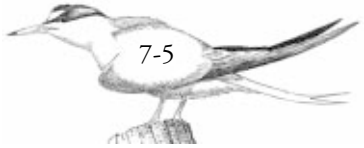
In the Office

The field data should be entered into a spreadsheet such as Microsoft Excel or a database such as Microsoft Access. A database is useful for storing large amounts of information and creating lists, queries, and reports from the data. Digital photographs and sketches can be stored in Microsoft Access. You can use a spreadsheet to store data, but a spreadsheet is better suited for performing computations and summarizing data.

For each sample site, create a spreadsheet with columns for date, site code, species name, number of individuals, and species traits. Table 1A and Table 1B (pages 7-7 and 7-8) are examples of spreadsheet design and include real data to illustrate key concepts of data entry and analysis. The main objective is to enter raw data into the spreadsheet and then use functions and tools available to compute percentages of species, species groups, or particular traits.

Volunteers interested in entering data and computing important **metrics** about the salt marsh **community** should follow all six steps in the following section, and then continue in the "Data Analysis and Comparison" section. If volunteers are only responsible for entering data, then they should perform steps 1-3 in the following section and then give the spreadsheet to the project leader for further analysis.

Eastern Kingbird



Steps in Data Entry

1. Enter site name, date, species, and number of individuals per species into the first four columns of the spreadsheet. Once you enter this information, it is useful to sort the species column alphabetically. Select all of the data you entered (not including column headings), go to Data → Sort, select the column "Species," and select "Sort Ascending." Alphabetizing the list makes it easier to locate each species on Appendix 1 and fill in species traits.

2. Table 1A and 1B have two columns for Location: WET (seen in wetland) and BUF (seen in buffer zone). The tables also have two columns for Behavior: SIT (seen sitting) and FLY (seen flying). Place the value 0 or 1 for each species depending on where you saw the species and what it was doing at the time. For example, in Table 1A the American Crow was seen sitting in the buffer zone, so you would enter the following values: WET = 0, BUF = 1, SIT = 1, FLY = 0. Complete these columns for all species. It is important to enter a value (0 or 1) for all cells in these columns.

3. Table 1A and 1B have columns for six important species traits that are used to compute metrics (names and abbreviations are listed in the table heading). For each species, place the value 0 or 1 into each of these columns depending on its individual traits — all of this information is provided in Appendix 1. Some species will have more than one of the six traits. For example, in Table 1A the American Crow is Resident (RES) and **Tolerant** (TOL), and therefore "1" is entered in these columns and "0" is entered in the other four columns. Do this for all species; it is important to enter a value (0 or 1) for all cells in these columns.

4. In the row "Total," count the number of species and enter this value in the column "Species." For example, Table 1A shows that 16 species were encountered at the study site. Sum the remaining columns using the SUM function in the spreadsheet program. The total for the column "#" represents the total number of birds (individuals) encountered during the survey, and the total for the remaining columns represent the total number of species. For example, the sum total of the column "NMIG" in Table 1A is 5, which means that 5 neotropical migrant species were encountered during the survey.

5. In the row "Percent Species," divide the number of species in the row "Total" by the total number of species encountered during the survey. For example, in Table 1A there were 10 tolerant species (TOL) encountered. To determine what percent of all species this represents, divide 10 by 16 (total number of species) and multiply by 100 to get a value of 62.5%. This number means that 62.5% of the species you saw at the site were tolerant species.

6. In the row "Percent Individuals," multiply the value (0 or 1) for each species in the columns "WET" through "RARE" by the number of individuals of each species (column "#") and sum these values for all species. This will allow you to calculate a percent abundance based on individual birds rather than species. For example, to compute the percentage of birds that were seen in the wetland (column LOCATION → WET), you would use the following formula:

   =(0 x 2) + (0 x 1) + (1 x 1) + (1 x 4) + (1 x 4) + (0 x 5) + (0 x 3) + (1 x 1) + (1 x 2) + (0 x 1) + (0 x 2) + (0 x 1) + (0 x 8) + (1 x 1) + (1 x 3) + (0 x 1) = 16.

   Divide this sum by the total number of individuals encountered during the survey and multiply by 100 to compute a percentage.=(16/40) x 100 = 40%.

   This number means that 40% of all individuals were seen in the wetland. If you are proficient with spreadsheets, you will only need to enter this long formula once, copy it to all other columns in the row, and have it calculate these percentages automatically.

You have now finished the most tedious portion of data entry and in the process you have computed some important metrics of the bird community. The following section talks about 10 important metrics and discusses how to compute them using the same example data we used in the Data Entry section.

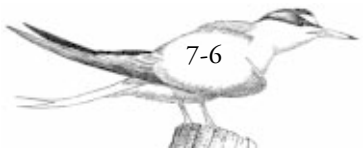


TABLE 1A. EXAMPLE DATA ENTRY SPREADSHEET FOR A STUDY MARSH

Column Abbreviations: # = Number observed, WET = Wetland, BUF = Buffer, SIT = Sitting, FLY = Flying, NMIG = Neotropical migrant, RES = Resident, TOL = Tolerant, AFOR = Aerial Foraging Species, R = Rare.

				LOCATION		BEHAVIOR		SPECIES TRAITS					
SITE	DATE	SPECIES	#	WET	BUF	SIT	FLY	NMIG	WET	RES	TOL	AFOR	RARE
Study	7/10/01	American Crow	2	0	1	1	0	0	0	1	1	0	0
Study	7/10/01	Black-Capped Chickadee	1	0	1	1	0	0	0	1	1	0	0
Study	7/10/01	Chimney Swift	1	1	0	0	1	1	0	0	1	1	0
Study	7/10/01	Common Grackle	4	1	0	0	1	0	0	0	0	0	0
Study	7/10/01	Double-Crested Cormorant	4	1	0	1	0	0	1	0	0	0	0
Study	7/10/01	European Starling	5	0	1	1	0	0	0	1	1	0	0
Study	7/10/01	House Sparrow	3	0	1	1	0	0	0	1	1	0	0
Study	7/10/01	Least Sandpiper	1	1	0	1	0	1	1	0	0	0	0
Study	7/10/01	Lesser Yellowlegs	2	1	0	1	0	1	1	0	0	0	0
Study	7/10/01	Northern Mockingbird	1	0	1	1	0	0	0	0	1	0	0
Study	7/10/01	Mourning Dove	2	0	1	1	0	0	0	1	1	0	0
Study	7/10/01	Northern Cardinal	1	0	1	1	0	0	0	1	1	0	0
Study	7/10/01	Rock Dove (Pigeon)	8	0	1	1	0	0	0	1	1	0	0
Study	7/10/01	Short-Billed Dowitcher	1	1	0	1	0	1	1	0	0	0	0
Study	7/10/01	Snowy Egret	3	1	0	1	0	1	1	0	0	0	0
Study	7/10/01	Song Sparrow	1	0	1	1	0	0	0	1	1	0	0
TOTAL		16	40	7	9	14	2	5	5	8	10	1	0
PERCENT SPECIES				43.8	56.3	87.5	12.5	31.3	31.3	50.0	62.5	6.3	0.0
PERCENT INDIVIDUALS				40.0	60.0	87.5	12.5	20.0	27.5	57.5	62.5	2.5	0.0

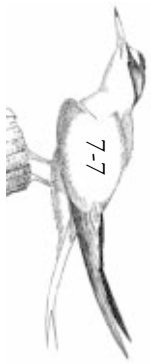
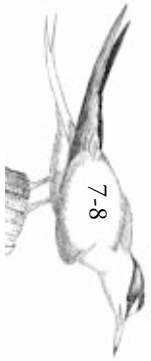


TABLE 1B. EXAMPLE DATA ENTRY SPREADSHEET FOR A REFERENCE MARSH

Column Abbreviations: # = Number observed, WET = Wetland, BUF = Buffer, SIT = Sitting, FLY = Flying, NMIG = Neotropical migrant, RES = Resident, TOL = Tolerant, AFOR = Aerial Foraging Species, R = Rare.

				LOCATION		BEHAVIOR		SPECIES TRAITS					
SITE	DATE	SPECIES	#	WET	BUF	SIT	FLY	NMIG	WET	RES	TOL	AFOR	RARE
Ref	7/10/01	American Crow	1	0	1	0	1	0	0	1	1	0	0
Ref	7/10/01	American Goldfinch	2	0	1	1	0	0	0	1	0	0	0
Ref	7/10/01	American Robin	1	0	1	1	0	0	0	0	1	0	0
Ref	7/10/01	Canada Goose	1	1	0	1	0	0	1	1	1	0	0
Ref	7/10/01	Chimney Swift	1	1	0	0	1	1	0	0	1	1	0
Ref	7/10/01	Common Grackle	1	1	0	1	0	0	0	0	0	0	0
Ref	7/10/01	Common Tern	1	1	0	0	1	1	1	0	0	0	0
Ref	7/10/01	Double Crested Cormorant	1	1	0	0	1	0	1	0	0	0	0
Ref	7/10/01	Gray Catbird	1	0	1	1	0	1	0	0	0	0	0
Ref	7/10/01	Great Black-Backed Gull	1	1	0	1	0	0	1	1	1	0	0
Ref	7/10/01	House Finch	1	0	1	1	0	0	0	1	1	0	0
Ref	7/10/01	House Sparrow	3	0	1	1	0	0	0	1	1	0	0
Ref	7/10/01	Least Sandpiper	7	1	0	1	0	1	1	0	0	0	0
Ref	7/10/01	Mallard	3	1	0	1	0	0	1	1	1	0	0
Ref	7/10/01	Northern Mockingbird	1	0	1	1	0	0	0	0	1	0	0
Ref	7/10/01	Mourning Dove	3	0	1	1	0	0	0	1	1	0	0
Ref	7/10/01	Northern Cardinal	1	0	1	1	0	0	0	1	1	0	0
Ref	7/10/01	Northern Rough-Winged Swallow	1	1	0	0	1	1	1	0	0	1	0
Ref	7/10/01	Song Sparrow	2	0	1	1	0	0	0	1	1	0	0
TOTAL		19	33	9	10	14	5	5	7	10	12	2	0
PERCENT SPECIES				47.4	52.6	73.7	26.3	26.3	36.8	52.6	63.2	10.5	0.0
PERCENT INDIVIDUALS				51.5	48.5	84.8	15.2	33.3	45.5	54.5	57.6	6.1	0.0



DATA ANALYSIS AND COMPARISON

Now that you have entered and compiled all of the field data, you can begin to explore what it means. This chapter uses 10 metrics to indicate the health of salt marsh bird communities. A complete analysis should include all of these metrics, and perhaps other metrics or indices developed to meet specifically project goals. The 10 metrics described in this chapter are still being tested for their ability to discriminate between different bird communities and wetlands, and though none of them works perfectly all of the time, collectively they provide a good summary of the bird communities in salt marsh environments. Table 2 lists each metric and provides a brief explanation of why it is used and its expected response to stressors.

Species Richness

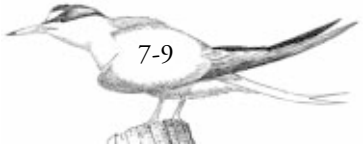
Description: Species richness is the total number of species observed during the study.

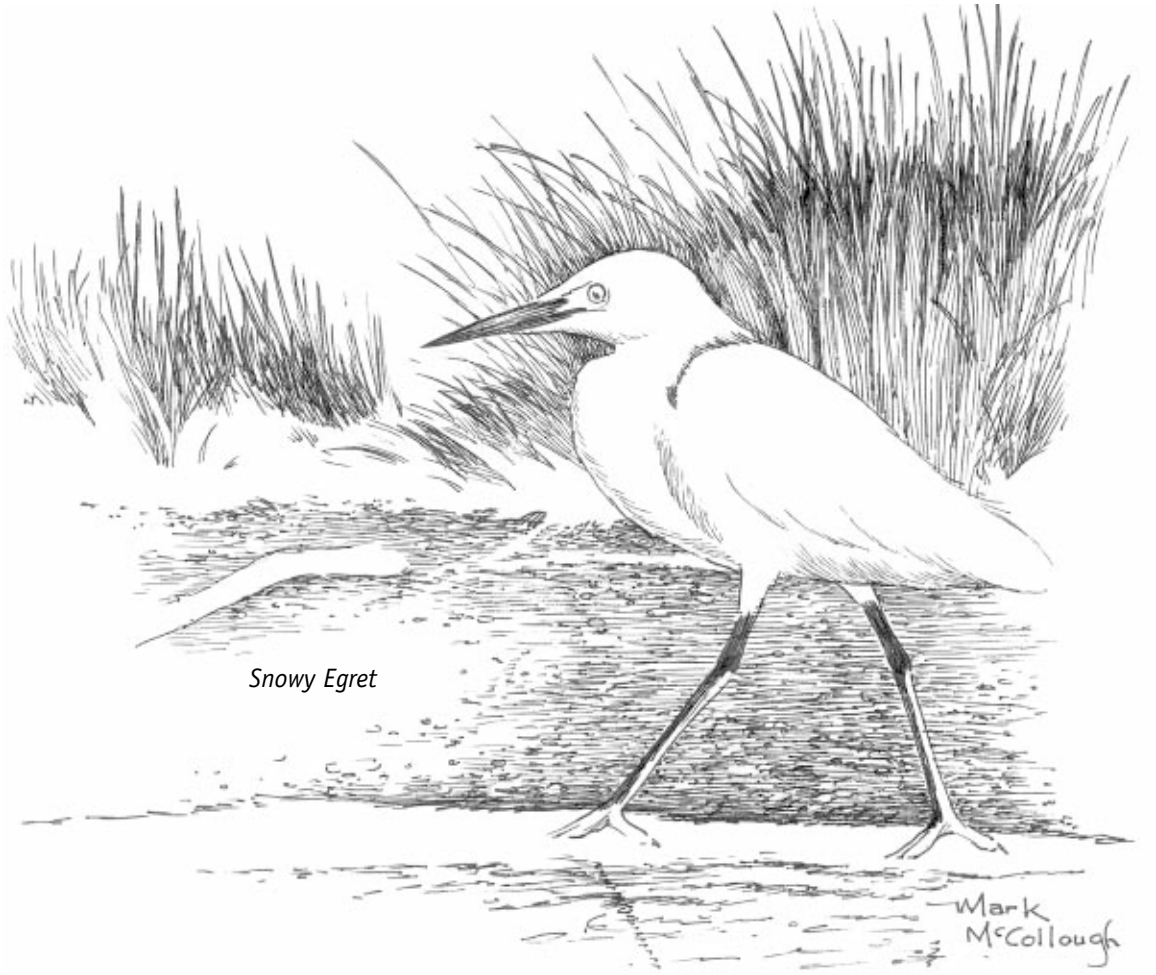
Calculation: Simply count the number of species observed at each site. From the example data in Table 1A and 1B, the species richness is 16 at the study site and 19 at the **reference site**. You can compute a ratio of species richness by dividing the number of species at the study site by the number of species at the reference site and multiplying by 100. For our example data, this ratio would be 84.2% (=(16/19) x 100). This means that the study site has 15.5% fewer species that the reference site.

Interpretation: Species richness is an important variable because in general pristine salt marshes will support more species than disturbed salt marshes. Usually, severe pollution or habitat degradation will eliminate sensitive species, thereby reducing species richness. This metric does not always reflect pollution or degradation, especially when there are natural habitat differences between two sites that are unrelated to stressors of interest.

TABLE 2. SUMMARY OF BIRD COMMUNITY METRICS

METRIC	RATIONALE	RESPONSE TO STRESSORS
Species Richness	Species richness is expected to be highest in sites where habitat quality and food supply are most optimal.	Decline
% Neotropical Migrants	Neotropical migrants are habitat specialists and sensitive to habitat quality.	Decline
% Wetland Dependent Species	Wetland-dependent species require habitat that ties them exclusively to healthy, aquatic sites.	Decline
% Resident Species	Resident species are less sensitive to habitat quality and tend to be habitat generalists.	Increase
% Tolerant Species	Tolerant species are generalists that adapt to human-altered habitats and landscapes.	Increase
% Starlings and Blackbirds	Starlings and blackbirds are tolerant species whose numbers are expected to increase in habitats that are degraded.	Increase
% Insectivorous Aerial Foragers	Flying, insect-feeding species depend on a healthy invertebrate population for food.	Decline
Number of Regionally Rare Species	Regionally rare species are expected to be found only in the best available habitat.	Decline
% Abundance of 3 Most Abundant Species	Overall species diversity will decrease under impacted conditions, allowing a few species to dominate.	Increase
Community Similarity Ratio	The percent similarity between reference sites and other similarly structured sites should be the same if they are healthy.	Decline





Snowy Egret

Percent Neotropical Migrants

Description: Neotropical migrants are species that migrate toward the southern hemisphere for the northern winter, and include species such as warblers and flycatchers. This metric is the proportional abundance of these species and individuals.

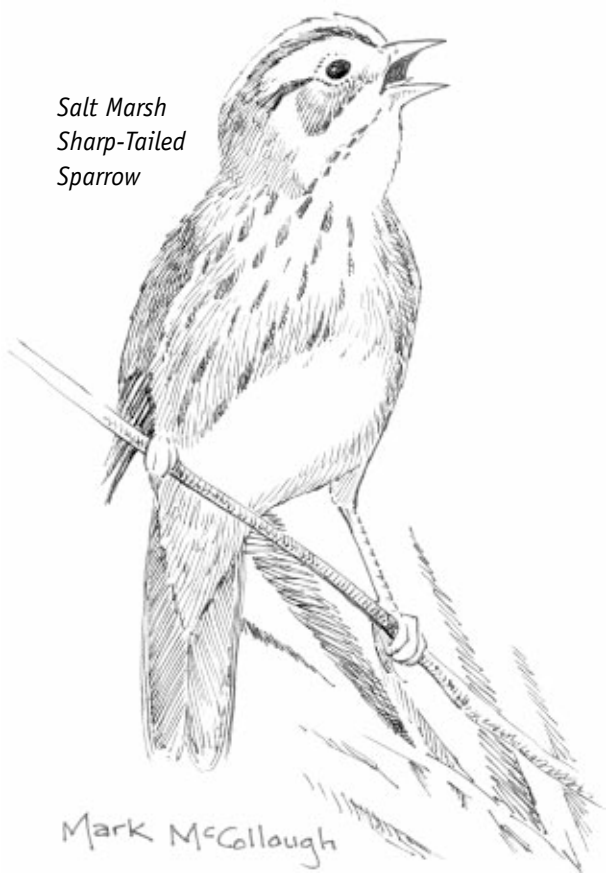
Calculation: Appendix 1 lists all of the neotropical migrants, and this information was transferred onto your spreadsheet during data entry. This metric can be computed for either species or individuals. From the example data in Table 1A and 1B, neotropical migrants comprise 31.3% and 26.3% of all species in the study site and reference site, respectively. When this is weighted by abundance, they comprise 20.0% and 33.3% of all individuals in the study site and reference site, respectively.

Interpretation: Most neotropical migrants are very sensitive species with specific habitat requirements. Higher quality wetlands are expected to support greater numbers of neotropical migrants. Time of year is an important consideration when using this metric, however, since migratory species are usually only encountered during the warmer months.

Percent Wetland-Dependent Species

Description: Wetland-dependent species are those species that rely on wetlands for some portion of their life cycle such as nesting or feeding, and include species such as Red-Winged Blackbirds, various shorebirds, ducks, and herons. This metric is the proportional abundance of these species and individuals.

Calculation: Appendix 1 lists all of the wetland-dependent species, and this information was transferred onto your spreadsheet during data entry. This metric can be computed for either species or individuals. From the example data in Table 1A and 1B, wetland dependent species



Salt Marsh Sharp-Tailed Sparrow

comprise 31.3% and 36.8% of all species in the study site and reference site, respectively. When this is weighted by abundance, they comprise 27.5% and 45.5% of all individuals in the study site and reference site, respectively.

Interpretation: Wetland-dependent species are more sensitive to habitat conditions and feeding opportunities in wetlands because they are strictly reliant on the wetland during critical phases of their life cycle. Polluted and degraded marshes can continue to support non-wetland species because they can forage in upland areas also. Thus, the proportional abundance of wetland-dependent species is expected to be higher in pristine marshes, and lower in polluted or degraded marshes.

Percent Resident Species

Description: Resident species — such as American Crows, House Sparrows, and Northern Cardinals — do not migrate, are generalists, and can shift their diets in response to seasonal or resource changes. This metric is the proportional abundance of these species and individuals.

Calculation: Appendix 1 lists all of the resident species, and this information was transferred onto your spreadsheet during data entry. This metric can be computed for either species or individuals. From the example data in Table 1A and 1B, resident species comprise 50.0% and 52.6% of all species in the study site and reference site, respectively. When this is weighted by abundance, they comprise 57.5% and 54.5% of all individuals in the study site and reference site, respectively.

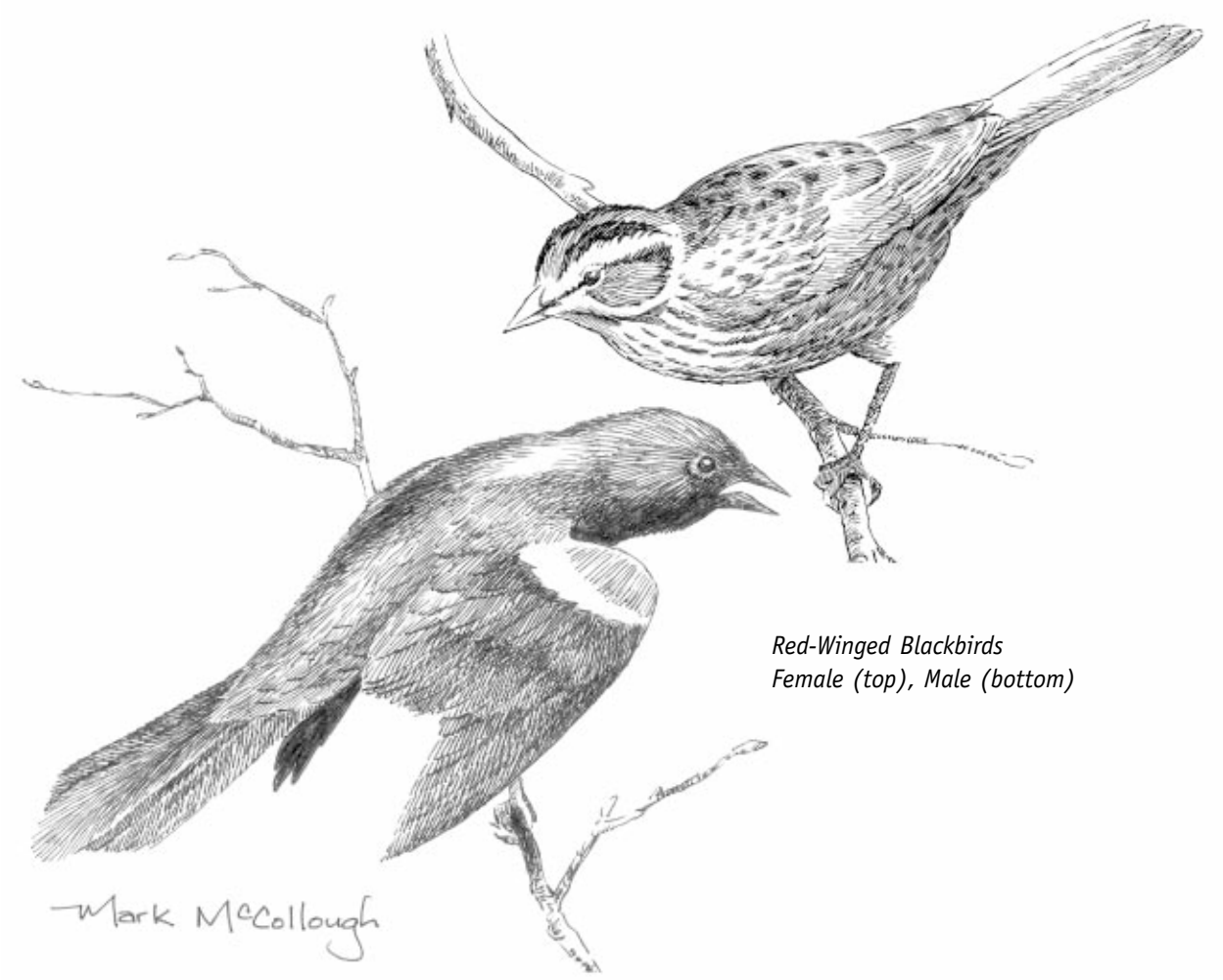
Interpretation: Since resident species have the ability to use different resources and adapt to scarce resources, they are better able to cope with alterations to food quality/quantity or habitat conditions that result from pollution or degradation. Therefore, resident species are expected to comprise a higher proportional abundance of the bird community in polluted or degraded marshes.

Percent Tolerant Species

Description: Tolerant species are generalists that are adapted to living close to man and his activities, but unlike resident species may be migratory or partially migratory. Examples include American Robins, Cedar Waxwings, Blue Jays, and American Crows. This metric is the proportional abundance of these species and individuals.

Calculation: Appendix 1 lists all of the tolerant species, and this information was transferred onto your spreadsheet during data entry. This metric can be computed for either species or individuals. From the example data in Table 1A and 1B, tolerant species comprise 62.5% and 63.2% of all species in the study site and reference site, respectively. When this is weighted by abundance, they comprise 62.5% and 57.6% of all individuals in the study site and reference site, respectively.

Interpretation: Similar to resident species, tolerant species have the ability to use different resources and adapt to scarce resources, and are better able to cope with alterations to food quality/quantity or habitat conditions that result from pollution or degradation. Sites that are suffering from environmental impacts should have more species that can tolerate such conditions.



Red-Winged Blackbirds
Female (top), Male (bottom)

Percent Starlings and Blackbirds

Description: Blackbirds and starlings are **opportunistic** feeders that often occur in large flocks, and are generally tolerant of **human disturbance**. In our area, these include European Starlings, Red-Winged Blackbirds, Brown-Headed Cowbirds, and Common Grackles. This metric is the proportional abundance of these species and individuals.

Calculation: You should look through the species list for each sampling date and record the presence and numbers of each the four species that comprise this metric. Divide the number of species by the total number of species recorded at each site, and divide the number of individuals of these species by the total number of individuals recorded at each site. Table 3 shows data for this metric extracted from the example data in Tables 1A and 1B.

Interpretation: Similar to resident and tolerant species, a high proportional abundance of blackbirds and starlings can be a signal of poor habitat quality, since these species, when in large post-breeding feeding flocks, are generalists, tolerant of man, and thrive in poorer quality habitats.

TABLE 3. PERCENT STARLINGS AND BLACKBIRDS
Data taken from Tables 1A and 1B

SITE	PERCENT ABUNDANCE	
	INDIVIDUALS	SPECIES
Study Site	22.5	12.5
Reference Site	3.0	5.3

Percent Insectivorous Aerial Foragers

Description: Warblers, swallows, and flycatchers are among the many species that feed by flying around and catching insects, and are dependent on healthy invertebrate communities. This metric is the proportional abundance of these species and individuals.

Calculation: Appendix 1 lists all of the aerial foraging species, and this information was transferred onto your spreadsheet during data entry. This metric can be computed for either species or individuals. From the example data in Table 1A and 1B, aerial foragers comprise 6.3% and 10.5% of all species in the study site and reference site, respectively. When this is weighted by abundance, they comprise 2.5% and 6.1% of all individuals in the study site and reference site, respectively.

Interpretation: Marsh pollution or habitat degradation that affects invertebrate communities is also expected to decrease the proportional abundance of birds that prey on invertebrates. A high proportional abundance of aerial foragers is a good indication that environmental conditions are suitable for a healthy invertebrate community. In addition, many of the insectivorous aerial foragers are also neotropical migrants with specific habitat needs.

Number of Regionally Rare Species

Description: Rare species are those with a restricted geographical distribution, or unusually specific habitat needs that only enable them to exist at extremely low population densities and a small number of locations. Examples include the Salt Marsh Sharp-Tailed Sparrow, Cliff Swallow, Least Tern, and Clapper Rail. This metric is simply the number of rare species and individuals.

Calculation: Appendix 1 lists all of the rare species, and this information was transferred onto your spreadsheet during data entry. From the example data in Table 1A and 1B, no rare species were encountered at the study site or reference site. The reason that this is not computed as a percentage or proportional abundance of the total community is because they occur very infrequently and in extremely low numbers.

Interpretation: The presence of rare species can sometimes be a good indicator of relatively pristine and healthy conditions, although you should exercise caution when interpreting this value because rare species are often found at unexpected times and unexpected locations and your observation may be largely due to chance.

Tree Swallow

Percent Abundance of Three Most Common Species

Description: This metric is a measure of dominance, and reflects the degree to which a community is dominated by a small number of species. In other words, it is a measure of how evenly distributed the species are in a community.

Calculation: To compute this metric, you need to compute the percent abundance of all species encountered at a site and then find the sum of the three highest values. The easiest way to do this is to copy the columns "Species" and "#" from Table 1 to a new spreadsheet, determine the percent abundance of each species by dividing the number of individuals of each by the total number of individuals and multiplying by 100, and then sort the data by these percentages. Table 4 shows what this looks like using data from Table 1A and Table 1B. For the study site, add Rock Dove (20%), European Starling (12.5%), and Common Grackle (10%) to compute a value of 42.5%. For the reference site, add Least Sandpiper (21.2%), House Sparrow (9.1%), and Mallard (9.1%) to compute a value of 39.4%.

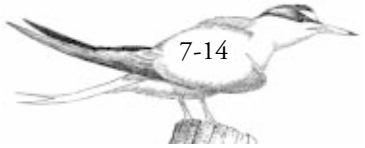
Interpretation: Marshes that are polluted or degraded often provide few feeding opportunities, and the bird community is usually dominated by a small number of tolerant species that can adapt to existing resources. Pristine and healthy marshes provide many opportunities for nesting or foraging, which allow many different species to coexist, and leads to a more equitable distribution of species. Therefore, this metric is expected to be higher in polluted or degraded marshes and lower in pristine marshes.

Community Similarity Ratio

Description: Community similarity refers to the types of species that occur in a community, and in particular the similarity or difference between two communities. Metrics for species richness and relative abundance were already calculated, yet two sites can have identical species richness and relative abundance and have entirely different species. Since different species have different environmental requirements, the types of species in a community provide clues about salt marsh condition.

TABLE 4. PERCENT ABUNDANCE OF THREE MOST COMMON SPECIES

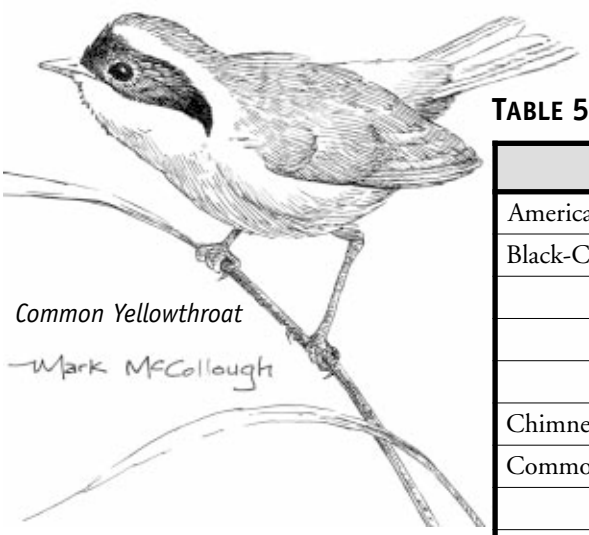
STUDY SITE	%	REFERENCE SITE	%
Rock Dove (Pigeon)	20.0	Least Sandpiper	21.2
European Starling	12.5	House Sparrow	9.1
Common Grackle	10.0	Mallard	9.1
Double-Crested Cormorant	10.0	Mourning Dove	9.1
House Sparrow	7.5	American Goldfinch	6.1
Snowy Egret	7.5	Song Sparrow	6.1
American Crow	5.0	American Crow	3.0
Lesser Yellowlegs	5.0	American Robin	3.0
Mourning Dove	5.0	Canada Goose	3.0
Black-Capped Chickadee	2.5	Chimney Swift	3.0
Chimney Swift	2.5	Common Grackle	3.0
Least Sandpiper	2.5	Common Tern	3.0
Mockingbird	2.5	Double-Crested Cormorant	3.0
Northern Cardinal	2.5	Gray Catbird	3.0
Short-Billed Dowitcher	2.5	Great Black-Backed Gull	3.0
Song Sparrow	2.5	House Finch	3.0
Three Most Common Species	42.5	Mockingbird	3.0
		Northern Cardinal	3.0
		Northern Rough-Winged Swallow	3.0
		Three Most Common Species	39.4



Calculation: One way to examine community similarity is to compare species lists from two or more sites and see how many unique species exist at each site. Copy the species lists from the data entry spreadsheet onto a new spreadsheet, place them side-by-side, and compare the species lists. Table 5 shows data taken from Table 1A and Table 1B. The study site has six unique species, the reference site has nine unique species, and the two sites share 10 species. You can calculate a community similarity ratio by dividing the number of species that the two sites share (10) by the number of species at the reference site (19) and multiplying by 100. From Table 5, the ratio is:

=(10/19) x 100 = 52.6%.

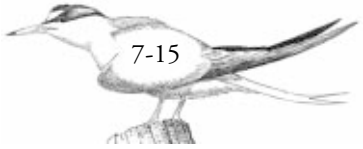
Interpretation: When interpreting community composition data, it is important to understand the ecology and environmental tolerance of the birds. The community similarity ratio is a quick way to judge the similarity of two sites, but the interpretation of this ratio is somewhat subjective. More importantly, you should look at the unique species from each site and consider what traits unite these species and why they are present at one site and not the other. Perhaps one site has a large number of sensitive neotropical migrants that are not found at another site, or a large number of resident or tolerant species that may indicate poor wetland conditions.



Common Yellowthroat

TABLE 5. COMMUNITY SIMILARITY EXAMPLE

STUDY SITE	REFERENCE SITE
American Crow	American Crow
Black-Capped Chickadee	
	American Goldfinch
	American Robin
	Canada Goose
Chimney Swift	Chimney Swift
Common Grackle	Common Grackle
	Common Tern
Double-Crested Cormorant	Double-Crested Cormorant
European Starling	
	Gray Catbird
	Great Black-Backed Gull
	House Finch
House Sparrow	House Sparrow
Least Sandpiper	Least Sandpiper
Lesser Yellowlegs	
	Mallard
Northern Mockingbird	Northern Mockingbird
Mourning Dove	Mourning Dove
Northern Cardinal	Northern Cardinal
Rock Dove (Pigeon)	
Short-Billed Dowitcher	
Snowy Egret	
	Northern Rough-Winged Swallow
Song Sparrow	Song Sparrow



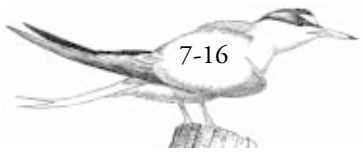
Summary

Once you have calculated each of the 10 metrics, it is useful to put all of the data into a summary table. Table 6 provides a summary of all metrics calculated using the example data in Table 1A and Table 2A. You should calculate metrics separately for each sampling day and then average these over the entire sampling period, except for species richness, which should be calculated by combining the data from all of the sampling days for one calculation.

TABLE 6. SUMMARY OF BIRD METRICS CALCULATED FROM EXAMPLE DATA

METRIC	STUDY SITE		REFERENCE SITE	
	INDIVIDUALS	SPECIES	INDIVIDUALS	SPECIES
Species Richness	-	16	-	19
% Neotropical Migrants	20	31.3	33.3	26.3
% Wetland Dependent Species	27.5	31.3	45.5	36.8
% Resident Species	57.5	50	54.5	52.6
% Tolerant Species	62.5	62.5	57.6	63.2
% Starlings and Blackbirds	22.5	12.5	3	5.3
% Insectivorous Aerial Foragers	2.5	6.3	6.1	10.5
Number of Regionally Rare Species	0	0	0	0
% Abundance of 3 Most Abundant Species	-	42.5	-	39.4
Community Similarity Ratio	62.5%			

Northern Harrier



REFERENCES AND OTHER SUGGESTED READING

These are just a sampling, and many other good field guides, audio recordings, and general bird biology books are also available.

Identification Guides

Kaufman, K. 2000. *Birds of North America*. Houghton Mifflin Company. [$20.00]

National Geographic Society. 1999. *Field Guide to the Birds of North America, 3rd Edition*. National Geographic Society. [$21.95]

Peterson, R.T. 1980. *Field Guide to Birds East of the Rockies*. Houghton Mifflin Company. [$18.00]

Sibley, D.A. 2000. *National Audubon Society Sibley Guide to Birds.* Alfred A. Knopf, Inc. [$35.00]

Behavior and General Biology

Attenborough, D. 1998. *The Life of Birds.* Princeton University Press. [$29.95]

Kaufman, K. 1996. *Lives of North American Birds.* Houghton Mifflin Company. [$35.00]

Sibley, D.A. 2001. *The Sibley Guide to Bird Life and Behavior*. Alfred A. Knopf, Inc. [$45.00]

Stokes, D. and L. Stokes. 1996. *Stokes Field Guide to Birds: Eastern Region*. Little Brown and Company. [$16.95]

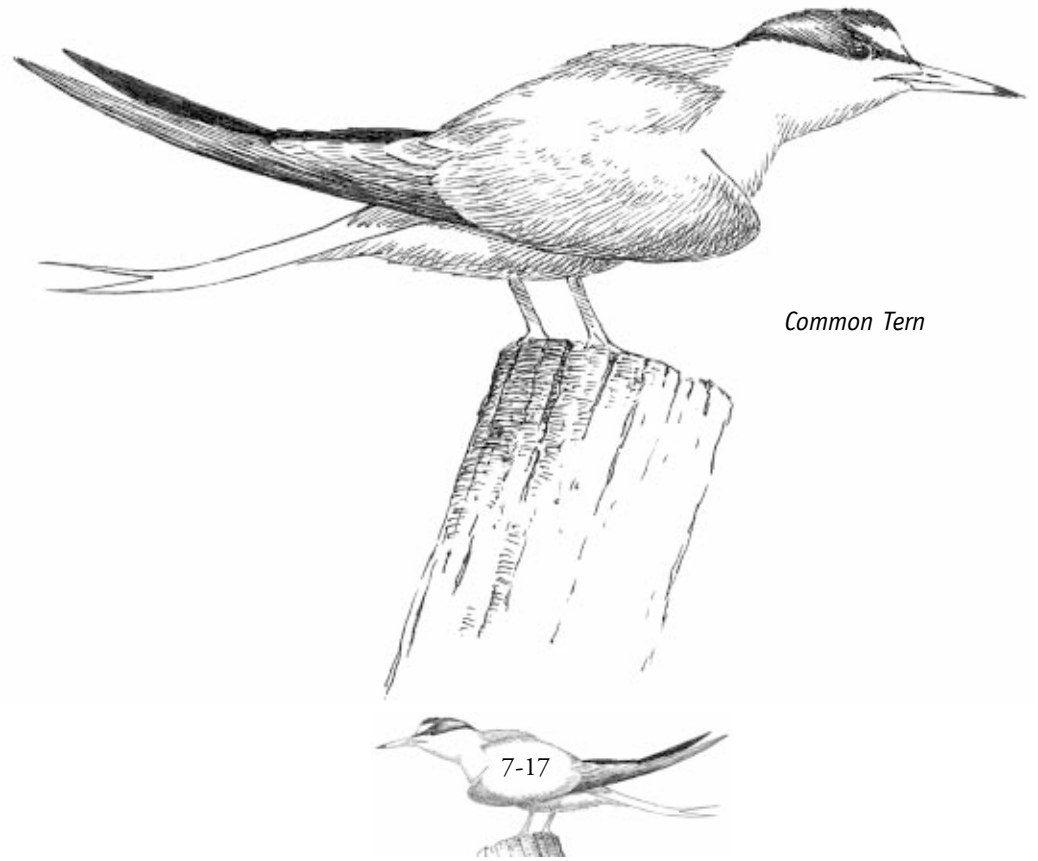
Sound Recordings

National Geographic Society. 1986. *Guide to Bird Songs*. National Geographic Society and the Cornell University Library of Natural Sounds. [1 CD, $ 24.95]

Peterson, R.T. 1999. *Field Guide to Bird Songs - Eastern/Central North America*. Cornell University Library of Natural Sounds. [2 cassettes or 1 CD, $ 29.95]

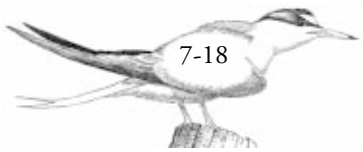
Walton, R.K. and R.W. Lawson. 1999. *Peterson Field Guides: Eastern/Central Birding by Ear.* Cornell University Library of Natural Sounds. [3 cassettes or 3 CDs, $25.00]

Walton, R.K. and R.W. Lawson. 1994. *Peterson Field Guides: Eastern and Central More Birding By Ear*. Cornell University Library of Natural Sounds. [3 cassettes or 3 CDs, $ 35.00]



Common Tern

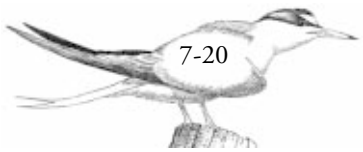
NOTES



chapter seven

APPENDICES

APPENDIX 1. BIRDS LIKELY TO BE SEEN NEAR SALT MARSHES
APPENDIX 2. AVIFAUNA SURVEY FIELD FORM



APPENDIX 1. BIRDS LIKELY TO BE SEEN NEAR SALT MARSHES

This list has been compiled from years of surveys near New England salt marshes and from knowledge about the ecology of each species. Though rare species may be encountered, this list should contain 95% of what you will find. Abbreviations: COM = Common, PRE = Present, RARE = Rare, WET = Wetland-dependent, AFOR = Aerial forager, NMIG = Neotropical migrant, RES = Resident, TOL = Tolerant

	SPECIES TRAITS							
SPECIES	COM	PRE	RARE	WET	AFOR	NMIG	RES	TOL
Double-Crested Cormorant	x			x				
Great Blue Heron		x		x				
Great Egret	x			x		x		
Snowy Egret	x			x		x		
Little Blue Heron			x	x		x		
Green (or Green-Backed) Heron		x		x		x		
Black-Crowned Night Heron		x		x				
Yellow-Crowned Night Heron			x	x		x		
Glossy Ibis		x		x		x		
Mute Swan		x		x			x	x
Canada Goose	x			x			x	x
Mallard	x			x			x	x
Black Duck	x			x			x	
Wood Duck		x		x				
Gadwall		x		x			x	
Northern Harrier		x		x				
Sharp-Shinned Hawk		x						
Cooper's Hawk		x						
Broad-Winged Hawk		x			x	x		
Red-Tailed Hawk		x			x		x	
Osprey		x		x		x		
Kestrel		x						
Merlin		x						
Pheasant		x					x	
Clapper Rail			x	x		x		
Virginia Rail		x		x		x		
Black-Bellied Plover	x			x		x		
Semipalmated Plover	x			x		x		
Killdeer	x			x		x		
Willet		x		x		x		
Greater Yellowlegs	x			x		x		
Lesser Yellowlegs	x			x		x		
Spotted Sandpiper		x		x		x		

APPENDIX 1. Continued

SPECIES	SPECIES TRAITS							
	COM	PRE	RARE	WET	AFOR	NMIG	RES	TOL
Whimbrel		x		x		x		
Ruddy Turnstone		x		x		x		
Dunlin		x		x		x		
Sanderling		x		x		x		
Semipalmated Sandpiper	x			x		x		
Least Sandpiper	x			x		x		
Short-Billed Dowitcher		x		x		x		
Wilson's Phalarope			x	x		x		
Laughing Gull		x		x		x		
Bonaparte's Gull		x		x				
Ring-Billed Gull		x		x			x	x
Herring Gull	x			x			x	x
Great Black-Backed Gull	x			x			x	x
Common Tern		x		x		x		
Least Tern			x	x		x		
Rock Dove (Common Pigeon)		x					x	x
Mourning Dove	x						x	x
Yellow-Billed Cuckoo			x			x		
Black-Billed Cuckoo			x			x		
Chimney Swift	x				x	x		x
Belted Kingfisher		x		x				
Northern Flicker	x							
Downy Woodpecker		x					x	x
Hairy Woodpecker		x						
Eastern Kingbird	x			x	x	x		
Great Crested Flycatcher					x	x		
Eastern Wood-Pewee		x			x	x		
Eastern Phoebe		x			x	x		
Willow Flycatcher		x		x	x	x		
Tree Swallow	x				x	x		
Purple Martin		x			x	x		
Bank Swallow		x			x	x		
Northern Rough-Winged Swallow		x		x	x	x		
Cliff Swallow			x	x	x	x		
Barn Swallow	x				x	x		
Blue Jay	x						x	x

APPENDIX 1. Continued

SPECIES	SPECIES TRAITS							
	COM	PRE	RARE	WET	AFOR	NMIG	RES	TOL
American Crow	x						x	x
Black-Capped Chickadee	x						x	x
Tufted Titmouse							x	x
White-Crested Nuthatch							x	
Red-Breasted Nuthatch		x						
House Wren		x						x
Marsh Wren		x		x				
Carolina Wren		x					x	
Golden-Crowned Kinglet		x						
Eastern Bluebird		x						
Wood Thrush		x				x		
American Robin	x							x
Water Pipit		x		x		x		
Gray Catbird	x					x		
Northern Mockingbird	x						x	x
Cedar Waxwing	x				x			
European Starling	x						x	x
Warbling Vireo		x		x	x	x		
Red-Eyed Vireo					x	x		
Nashville Warbler					x	x		
Black and White Warbler						x		
Chesnut-Sided Warbler					x	x		
Prairie Warbler					x	x		
Yellow Warbler	x			x	x	x		
Wilson's Warbler		x			x	x		
Yellow-Rumped Warbler		x			x	x		
Ovenbird						x		
Common Yellowthroat	x			x		x		
American Redstart		x			x	x		
Rose-Breasted Grosbeak						x		
Northern Cardinal	x						x	x
Scarlet Tanager						x		
Indigo Bunting						x		
Eastern Towhee	x							
Salt-Marsh Sharp-Tailed Sparrow			x	x				
Seaside Sparrow			x	x				

APPENDIX 1. Continued

SPECIES	SPECIES TRAITS							
	COM	PRE	RARE	WET	AFOR	NMIG	RES	TOL
Song Sparrow	x						x	x
Savannah Sparrow	x							
Field Sparrow								
Chipping Sparrow		x						
Swamp Sparrow	x			x				
Bobolink		x				x		
Eastern Meadowlark								
Red-Winged Blackbird	x			x				
Brown-Headed Cowbird		x						
Common Grackle	x							
Baltimore Oriole	x					x		
Orchard Oriole	x					x		
American Goldfinch	x						x	
Purple Finch		x						
House Finch	x						x	x
House Sparrow	x						x	x

AVIFAUNA SURVEY FIELD FORM

Investigators: _____ Date: _____

_____

_____

_____

Wetland Area: _____ Study or Reference (Circle)

Begin Time: _____ End Time: _____ Tide: Ebb Low Flow High (Circle)

Conditions: _____

COMMON NAME	#	LOCATION	ACTIVITY	NOTES
		Wetland / Buffer	Sitting / Flying	
		Wetland / Buffer	Sitting / Flying	
		Wetland / Buffer	Sitting / Flying	
		Wetland / Buffer	Sitting / Flying	
		Wetland / Buffer	Sitting / Flying	
		Wetland / Buffer	Sitting / Flying	
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		Wetland / Buffer	Sitting / Flying	

COMMON NAME	#	LOCATION	ACTIVITY	NOTES
		Wetland / Buffer	Sitting / Flying	
		Wetland / Buffer	Sitting / Flying	
		Wetland / Buffer	Sitting / Flying	
		Wetland / Buffer	Sitting / Flying	
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		Wetland / Buffer	Sitting / Flying	

ADDITIONAL NOTES AND COMMENTS